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The Origin and Development of the Earth.

BY CARROLL LANE FENTON

Geology is the science which treats of the materials, the constitution, and the development of the earth. The history of the events which have brought this planet and its inhabitants to their present state of being forms one of the principal divisions of the science. Of necessity such a history had a beginning, and concerning this beginning men have ever been prone to speculate. At first these speculations were the mere superstitions contrived in the minds of untutored savages, and we may find many of them in the mythology of the Indians of our own country. Later, in the beginnings of civilization, the philosophers of their time advanced ideas—less erratic and superstitious, perhaps, but hardly less impossible of truth than those of their savage ancestors. But gradually things changed. The invention of the telescope and the study of physics taught man much. Speculation and guesswork slowly gave way before scientific investigation, and within the last few decades there has been a more or less organized effort on the part of the world's greatest scientists to put to use the combined resources of chemistry, astronomy, physics, and geology in order to find a solution for the problem before them. That their efforts have not been without success may be seen when the various hypotheses in which they have resulted are considered.

Some suggestions as to the birth of our planet may be found in a study of its relations to the other bodies of the solar system, and in its characteristics as a member of that system. We may feel quite certain in saying that no such complicated organization as that which is displayed by the sun and its attendant bodies ever came into existence by accident. Beyond possibility of question the story of the birth of the system would be revealed in its organization and forces, were man only able to read that record. But in spite of the fact that we can give no positive definite interpretation of the remaining traces of the earth's beginning it is necessary, in order to carry on investigation, to form hypotheses to explain them. It is also important that we study these hypotheses carefully and note the various ways in which they may enter into the doctrines and ideas of modern science. Not a few of the principles of geology, astronomy, and even biology rest upon some hypothesis of the earth's origin, and have no greater strength than that of the hypotheses on which they are founded.

1.—The Laplachian Hypothesis.

It is the almost universal opinion among astronomers that the solar system was evolved from some sort of a nebula. Until comparatively recently most of them accepted a special hypothesis advanced in the latter part of the eighteenth century by the great French mathematician Laplace. So general was the acceptance of Laplace's idea that it came to be known as the "Nebular Hypothesis," without consideration of the fact that there were several other hypotheses which also supposed that the solar system was derived from a nebula. This explanation of Laplace's was supposed to offer a thoroughly satisfactory interpretation of the existing evidence as to the origin of the solar system, and therefore of the earth. But with the advance of geological and astronomical knowledge it became evident that the Laplacian hypothesis did not satisfactorily explain the origin of the earth, and that a new interpretation was necessary.

The Laplacian, or as it is popularly called, the Nebular Hypothsis has, however, gained so firm a foothold in literature and general knowledge that we must give it a careful survey before passing on to newer and more satisfactory ideas. Laplace supposed that the solar system was descended from an immense, rotating ball of gas which extended beyond the orbit of the outermost planet—that is, which had a diameter of more than 5,600,000,000 miles. This ball of gas, which supposedly contained all of the material in the solar system today, possessed at its beginning a very high temperature which it immediately began to lose, just as any hot object will lose its heat. This loss of heat caused shrinkage of the mass, and therefore increased rapidity of rotation. In the course of this rotation great rings of gas, one ring for each of the planets, were left by the contracting central mass. These rings, it is supposed, resembled those about the planet Saturn—in fact it is quite probable that the Saturnian rings suggested this part of the hypothesis. The rings in turn broke up, formed spheres, and in time gave off smaller rings to become the satellites.

According to this interpretation, the earth was originally a globe of very hot vapor which in the course of time cooled, contracted, and gave off a ring which went through the same process and became the moon. The parent mass continued to cool and shrink until it became liquid, and finally formed a crust over its outer surface, the interior still remaining very hot. At this early stage of the earth's history the atmosphere contained all of the gases which now compose it, great quantities of gases that are now united with other elements as parts of the rocks, and all of the hydrogen and oxgen that are now in the waters of the planet. When the cooling process had gone on for so long that gases formerly in the atmosphere could stay in the earth, and those falling as water could remain upon it instead of passing back as vapor, the ancestors of our present oceans began to form.

The hypothesis is skilfully devised, and carefully worked out in many of its details. But in many respects it contains glaring anomalies, and many of the conditions on which it depends could never have existed. In the first place, let us consider the supposed parent nebula a little more closely. The total amount of matter which it contained is now in the solar system—no more, no less. Its diameter was, of necessity, at least 5,600,000,000 miles, and the original hypothesis calls for an even greater figure. Dr. Moulton, of the University of Chicago, has computed that in such a nebula the density would be only one two-hundred-forty millionth of that of air at sea-level—thousands of times more rarified than the most perfect vacuum that man has been able to produce. How such a nebula, too thin to be perceived by any of our instruments, could have held itself together, and could have retained its heat for any length of time is impossible to understand. Likewise it is impossible that such a nebula should have given off a single ring, even at its earliest stages, or how such a ring, had it been formed, could have condensed into a sphere that could in time become a planet. As well ask the ring of smoke blown from your cigar or pipe to become a ball.

There are also movements of certain of the planets and their satellites that argue strongly against the Laplacian idea. If satellites evolved from rings that come from rotating planets, they should revolve around those planets in the same directation and with the same speed that the planets themselves turn upon their axes. Now the inner satellite of Mars revolves about the planet three times while Mars turns on its axis once, and the ninth satellite of Saturn has been shown to move in a direction opposite to the one in which the planet itself turns. Under the Laplacian hypothesis these things could not be, yet they unquestionably have been observed.

There is, however, one other line of argument which would dispose of the "nebular" hypothesis even though there were no other points against it. The moment, or amount, of momentum of any freely rotating system such as that to which our earth belongs must forever remain constant; that is a well-established principle of physics. In any ancestor of our solar system the moment of momentum must have equaled that of the present system, for the matter composing the one composes the other. But we find that such a nebula as the one postulated by Laplace could not have thrown off a ring until it had shrunk far within the orbit of the innermost planet. In order for this nebula to have produced the supposed ring from which Neptune was to descend it must have possessed at at least 200 times the momentum that is in the solar system today. *And yet the moment of momentum of any freely rotating system must forever remain constant.*

Or let us consider matters from another angle. If the Laplacian hypothesis were correct, the amount of momentum which a planetary ring could possess should be directly proportional to the amount of material in that ring; the greater the ring, the greater the moment of momentum. Now the mass of material composing the ring from which Jupiter and his suns supposedly descended was about one one-thousandth part of that of the parent nebula at that particular stage of its development, but these same planet and satellites contain 95 percent of the solar nebula at that stage. Equally striking discrepancies appear when the momentum of the other planets is considered. In other words, the Laplacian hypothesis seems to demand that the solar system be so organized that the planets and satellites, amounting to about one seven-hundredth of the total mass of the system, were able to carry off more than 97 percent of its total momentum. *There is no law of physics or astronomy that will allow for such a condition.*

So far, the arguments against the nebular hypothesis which we have considered have been principally astronomical, and credit for their discovery and elaboration must be given to Dr. F. R. Moulton, the first astronomer to seriously consider the difficulties in the way of Laplaceism. There are other arguments, perhaps equally strong, coming from the geologists and paleontologists, but these will be left for consideration farther on in the paper. On the whole, the Laplacian hypothesis must be given up. The idea of a molten globe which is gradually cooling and losing its atmosphere; of the moon as a dead body, and the earth and Mars as dying ones is very poetic but it fails to stand the test of modern science. Writers of feature articles for Sunday papers, and of "popular" books on alleged science still favor the old idea, for it works up excellently into sensational treatment. We must, however, as did geologists and astronomers of thirty years ago, look for another solution.

2.—The Meteoritic Hypotheses.

No matter how great the popularity of any hypothesis there are bound to be people who will disagree with it and advance other ideas, and the Laplacian hypothesis was no exception to this rule. Hundreds, even thousands of years before Laplace's time it had been noted that "shooting stars" enter the atmosphere in great numbers, and that occasionally fragments of stony or metallic material fall to the earth. From the observation of these meteors and meteorites arose the idea that the earth had been built up from them, the rate of infall being more rapid in the early history of the process. The great irregularity in the motions and velocities of the observed meteorites soon shows that this explanation fails to account for the development of any such orderly and harmonious motions as are to be seen in the solar system.

George Darwin, a son of the great Charles Darwin, still thought he saw in the infall of meteors and meteorites a possible solution of the origin of the solar system. He believed that meteorites might be brought together into swarms, thus constituting nebulae. These nebulae would, according to Darwin, behave essentially as though they were composed of gases, and the laws of gases might be used in determining their mechanics. If this were the case, the same objections which have been raised against the Laplacian hypothesis apply to the one sponsored by Darwin and Lockyer, so it need not be given further attention.

3.—The Planetesimal Hypothesis.

When the failings of the Laplacian hypothesis became so evident, and the hypothesis of Lockyer and Darwin showed itself to be unreliable—in fact, less satisfactory than that of Laplace—an alternative more suited to the facts was looked for. Earlier astronomers and astrophysicists had maintained that the matter of a nebula, if composed of particles revolving around their common center of gravity, could not come together into planets without giving them a backward motion. The six inner planets of the solar system have forward rotations, and for the time being all hypothesis of the *strictly* nebula type seemed to be ruled out. A more careful survey, by Doctors Moulton and Chamberlin, showed that this conclusion was wrong, and that there was no initial barrier in the way of a hypothesis in which the solar system was supposed to be descended from a nebula. It was also shown by astronomic photography that there were many times the number of nebulae that there formerly were thought to be, and it was to these that Dr. Chamberlin turned his attention.

The nebulae known at the present time seem to fall into two classes, when studied with the spectroscope. The first class is characterized by bright spectral lines which indicate a structure somewhat akin to gaseous, although it is not certain that this is the actual condition. Due to the fact that these nebulae show the presence of some elements not known to exist in any part of the solar system, and since there is absolutely no indication of metals in their constitution, they have been ruled out. It is, of course, conceivable that the elements composing these nebulae might in the course of time become elements such as we know, but is mere supposition, and will not suffice as a ground for basing a hypothesis.

The other class of nebulae give what are called "continous line" spectra, which is commonly interpreted to mean that the materials composing them are in either liquid or solid state. It is also almost certain that these nebular materials are in very finely divided particles, for in spite of the immense size of the nebulae they are known to intercept very little light and possess but slight gravitative power. Their spectra show, it seems, the presence of the same elements that compose the solar system, and their number is at least ten times as great as that of the nebulae of the "bright line" type.

The dominant type of these nebulae is the *spiral*, as was determined by the great astronomer Keeler, for years the director of the Lick Observatory. The distinguishing characteristic of the spiral nebulae is a central mass or ball with two arms which arise from opposite sides of the central mass and curve concentrically away from it. In the outer regions of these arms they commonly branch, but throughout all of the spiral nebulae the two dominant arms may be distinguished. In these nebular arms there are also considerable knots between which the nebulous matter is irregularly distributed. It is clear, from oblique views of the nebulae, such as that of Andromeda pictured in the accompanying plate, that the spirals are roughly disk-like, a shape which corresponds with that of the solar system.

The results of their study of the various characteristics of the spiral nebulae convinced Chamberlin and his associates that here, if anywhere among the astronomical bodies, they might successfully look for the traces of the earliest history of the solar system. While nothing is as yet known of the motions of the parts of these spirals, their shape seems to indicate that they are the products of combined outward and rotatory movement. The former is indicated by the protuberance of the arms, the latter by their pronounced coiling. Such a supposition calls for the existence of an earlier body that embraced the whole mass, and from which the present nebula is descended. We are forced to look, not only for the ancestor of the solar system, but for the ancestor to that ancestor. Such exploration must, of course, possess a good deal of uncertainty, and its results must be taken, as the saying is, with a grain of salt. Nevertheless, where there are thousands of known cases similar to that under consideration—i. e., the spiral nebula—and in all of these cases the same results are evident, it is not out of the way to suppose that the same causes apply throughout. What the scientist must do in such a case is to determine what conditions might produce the results observed, and take the most satisfactory of the hypotheses as the one on which to base his further work.

This is precisely what Professor Chamberlin did. The body most apt to produce a nebula of any sort is a sun, and of these there are more than 100,000,000 known, besides an unknown multitude of dark bodies which move through space, and of whose existence we have no definite knowledge. Among such a throng of celestial bodies it is almost inevitable that collisions should have occurred during the billions of years which the universe has been in existence. These collisions would naturally occur in the regions where stars are thickest, and it is worthy of note that in such a region, the Milky Way, the number of new stars—stars which appear where none were before—and also the number of bright line or free-molecular nebulae, are the greatest. This does not mean that the new stars and the bright line nebulae necessarily arise from the collision of two celestial bodies, but it does give weight to the statement that such collisions occur.

If collisions between stars occur, as it is almost certain they do, there must be much greater probability of close approach of the stars to one another or to dark bodies. There are several astronomical considerations which make it probable that close approach rather than actual collision is responsible for the origin of the spiral nebulae, and it was therefore selected by Chamberlin. It must be remembered, however, that the planetesimal hypothesis, as the proposed explanation of Chamberlin and Moulton is called, does not rely upon any set origin of the spiral nebulae; it merely proposes an origin for them. Its true basis is the existence of the spirals, which is unquestioned.

Our present sun shoots out great protruberances to the heights of many thousands of miles at velocities which, were it not for the great weight of the sun's atmosphere, would carry them to the outer limits of the solar system, or perhaps even beyond it. Let us now suppose that another sun were to approach ours. The attraction between the two, due to gravity, would greatly increase the tension upon the sun, and would thus cause great tidal protuberances to arise. These protruberances, were the forces causing them great enough, might well leave the sun, never to return. Of such material, arising much as in the manner briefly outlined above, the planets and satellites are supposed to be composed.

We have said that the forms of the spiral nebulae seem to imply that they originated through two types of movement—outward, and rotatory. The outward movement we have just accounted for in the projection of the protruberances from the parent sun through the attraction of another sun passing relatively near it. It now remains for us to account for the rotatory motion.

The protuberances would, according to this hypothesis, be thrust out as the ancestral sun and the passing star were swinging about their common center of gravity. The protuberance shot from the sun in the direction of the star would be drawn into a curved path by the attraction of the star, and the same would be true of the opposite projection, but to a lesser extent. The accompanying diagram, taken from Moulton shows how this would develop a spiral from the partially disrupted sun. Since in the course of rotation the inner parts of the spiral moved more rapidly than the outer, just as the small hand of a clock rotates more rapidly than the large, the arms became more closely coiled, finally developing a closely coiled spiral probably somewhat similar to the accompanying restoration. Since the parent sun was gaseous, as it is today, the particles composing the arms must have originally been in a free molecular state. Their enormous dispersion, with corresponding opportunity for cooling would soon make of them liquid or solid particles revolving about the sun as their common center of gravity. These particles were the originals of the planetesimals, or as the word means, "little planets."

We now have the spiral nebula, ready for the final development into the solar system. In it are five elements which are to perform the leading parts in the evolution of a planetary system from the spiral. They are:

1. The great central mass (to become the sun.)
2. The main knots in the arms (to become the planets.)
3. Minor arm knots near the large knots, and more or less controlled by them (to become nuclei for the satellites.)
4. Small, scattered knots (to become nuclei of the asteroids.)
5. Scattered nebulous matter (to be added to the nuclei or sun.)

It is assumed that in the early spiral nebula the small particles, or planetesimals, possessed elliptical orbits, as do the bodies of the solar system at the present time. All of these orbits would have as their gravitative center the sun, as would also the orbits of the nuclei. In the course of their passages through space the various bodies, both nuclei and planetesimals, would either pass near to each other or collide and as a result the small particles would be drawn to the larger particles, and these in turn to the nuclei. We thus have the nuclei, or beginnings, of the planets gradually increasing in size by the aquisition of the scattered fine material of the nebula. How long this may have taken—how many thousands of millions of years the growth of a planet occupied—we have no means of telling, but without doubt it was many.

How small the nucleus of the earth was we do not know, just as we do not know how rapidly it was built up. We know that the process has not yet ceased, for every year millions of meteors come within the atmosphere. Most of them become dust before reaching the surface of the earth, but the larger ones occasionally pass through the atmosphere without being totally destroyed, and reach the earth as meteorites. Obviously the process is now going on much more slowly than it was during the early history of the system, for the larger bodies were undoubtedly acquired early in the growth of the planet.

This conception of the origin of the earth differs, as can be readily seen, from the one proposed by Laplace. According to it the earth, instead of having shrunk from a ball much larger than it now is, has been built up from a mass the smallness of which cannot be determined. The moon, instead of being descended from a ring left behind by the contracting earth, had its origin in much the same manner as did our planet. Since it was never so large as the earth, and is quite near to it, it is controlled by the earth just as the earth is controlled by the sun.

We now come to the question which proved the undoing of the Laplacian hypothesis—that of movement and rotation of the planets and satellites. But according to Chamberlin's hypothesis there would be no fixed relation between the rotation of a planet and the revolution of its satellites. The rotation of either a planet or satellite may be forward, or it may be retrograde. The former would be the rule and the latter the exception, and this is precisely the case with the solar system. There are many other features of the solar system to be fittingly explained by the planetesimal hypothesis. Certain of them possess added weight because they were not discovered until after the hypothesis had been formulated and published. Any hypothesis, if it is to be considered at all, must explain the facts which are known and considered when it is being formulated. But the hypothesis which merits serious study or even acceptance is the one which explains conditions that were unknown to its authors. This the planetesimal hypothesis of Chamberlin and Moulton to do.

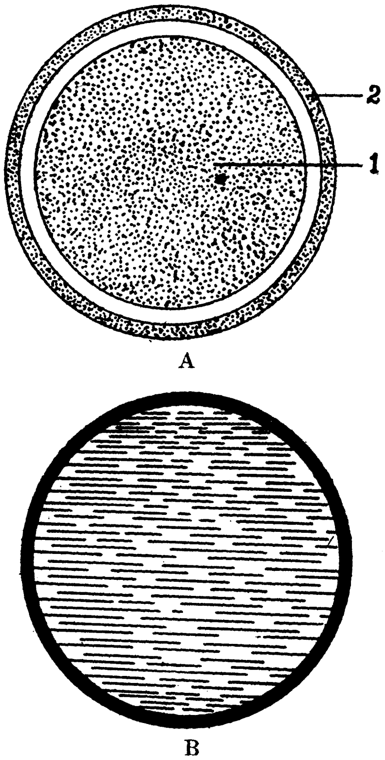

FIGURE 1.

A

Diagram of the supposed earth-moon stage of the Laplacian hypothesis. 1 is the central mass which is to form the earth, and 2 the ring which supposedly condensed into a ball and became the moon.

B

The earth on the Laplacian hypothesis. The heavy black portion represents the supposed solid "crust"; the lined disc represents the "molten interior."

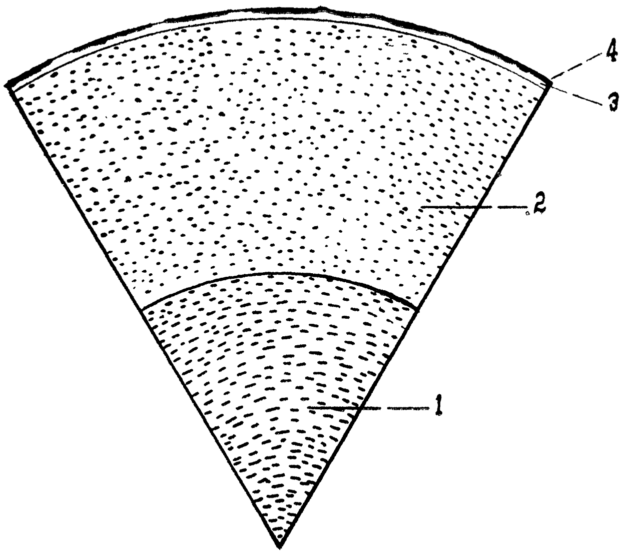

FIGURE 2

A section of the earth on the basis of the Planetesimal Hypothesis (after Chamberlin and Salisbury). The inner division 1, represents original planetesimal matter, with some igneous rocks. The second zone 2, represents the times of earliest sedimentation. Planetesimal matter still dominates, but there is much igneous rock, and some sedimentary. rocks, now changed by pressure and other agencies. 3 is a zone rocks, now much changed by pressure and other agencies. 3 is a zone of lavas and other igneous rocks, largely volcanic, with some sedimentary rocks. It represents the deposits of the time when planetesimals became few and small, but the pressure of the growing earth caused much vulcanism. 4 is the newer rocks, mostly sedimentary, representing deposits made from the times of the earliest known abundant fossils to the present.

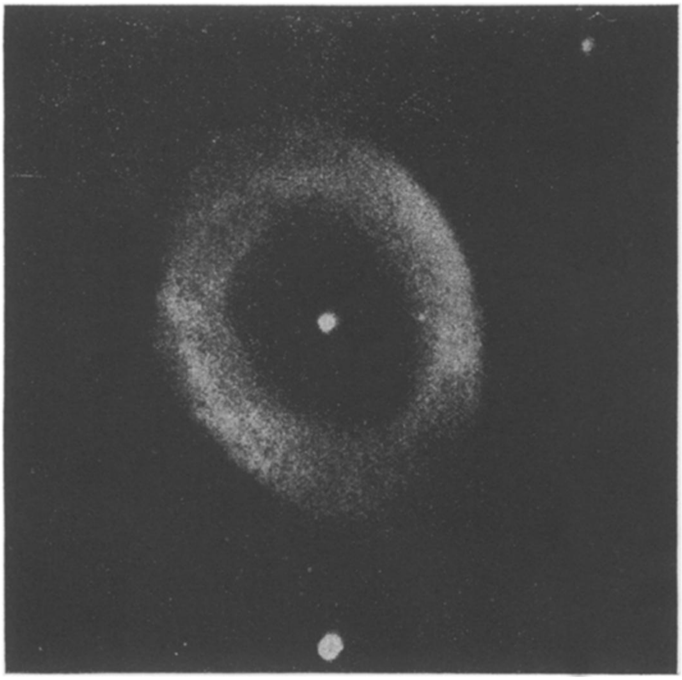

FIGURE 3.

The ring nebula in the constellation Lyra. This nebula seems to be a great vortex of the smoke-ring type, and may be due to the center-to-center collision of two large suns. From Chamberlin. Photographed at the Lick Observatory.

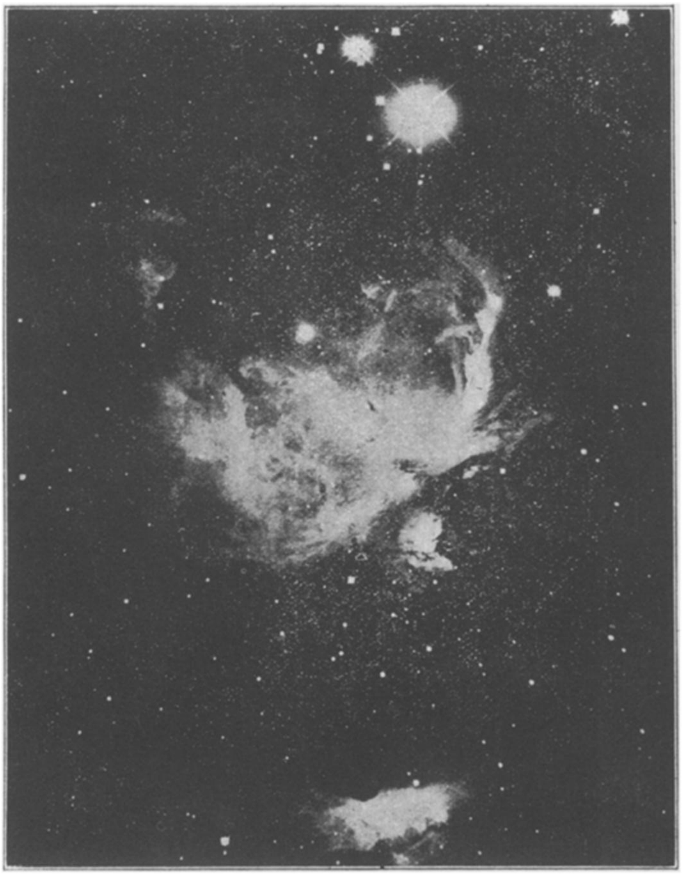

FIGURE 4.

The great nebula in Orion, and the Fish-Mouth Nebula. There are several great nebulae of this type known, but these are the most notable examples. They seem to have been co-partners in a mutual collision at rates of many thousands of miles per second. Photographed at the Yerkes Observatory. From Chamberlin, University of Chicago Press.

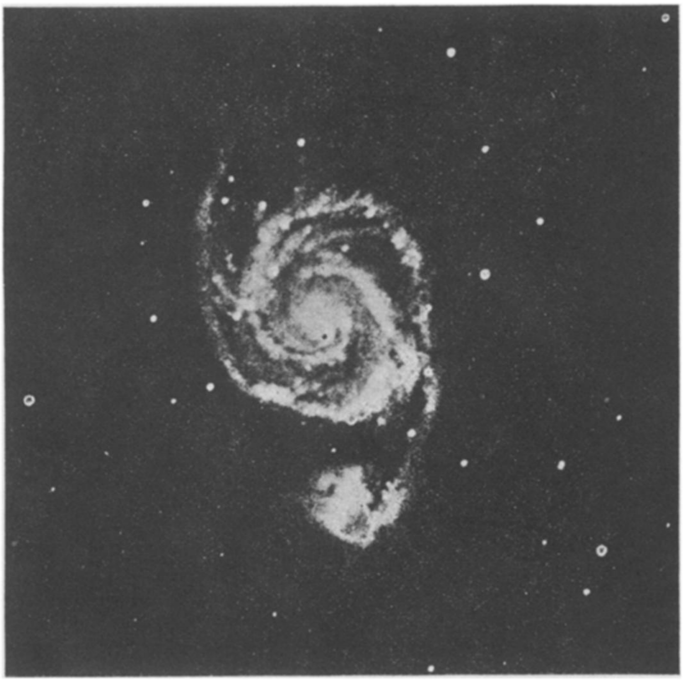

FIGURE 5.

The remarkable spiral nebula, M 51, in the constellation Canum Venaticorum, or the Hunting Dogs. This nebula shows with remarkable clearness the great central mass from which extend two partly coiled arms. In these arms can be seen large knots, which play so important a part in the conception of the Planetesimal Hypothesis. Photographed at the Yerkes Observatory. From Chamberlin, University of Chicago Press.

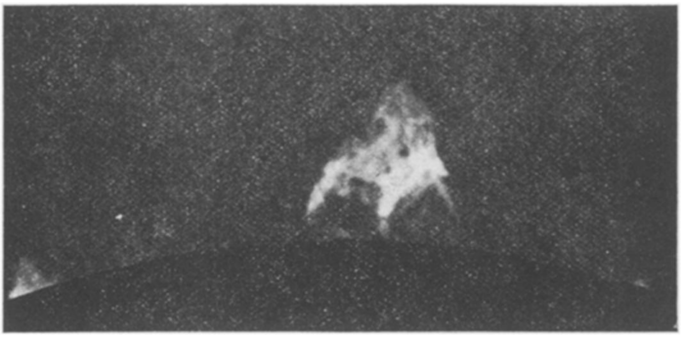

FIGURE 6.

An eruptive prominence of the sun, photographed at Yerkes Observatory on March 25, 1910. This prominence is but one of the many that are constantly being shot forth from the surface of the sun, rising many thousands of miles above its surface, and traveling at a speed of hundreds of miles per second in some cases.

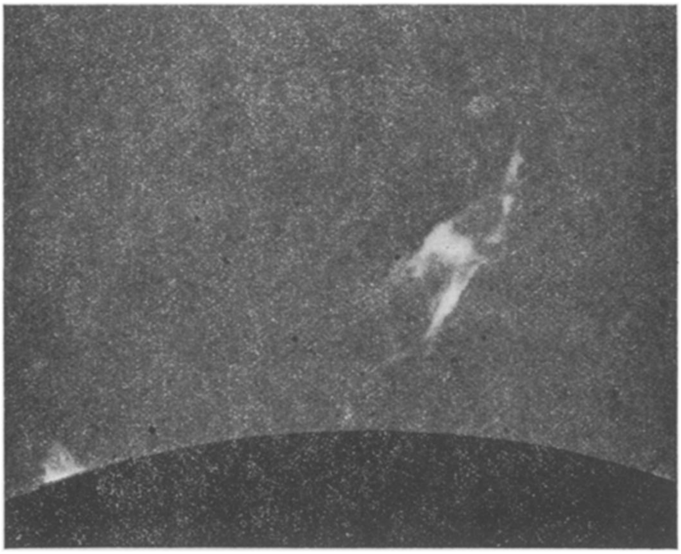

FIGURE 7.

The same prominence shown in Figure 6, photographed 43.2 minutes later. The immense size of the prominence, and the great speed which it possesses may be judged by comparison with the previous figure, and with the curvature of the visible portion of the sun's outline. Photographed at the Yerkes Observatory. From Chamberlin, University of Chicago Press.

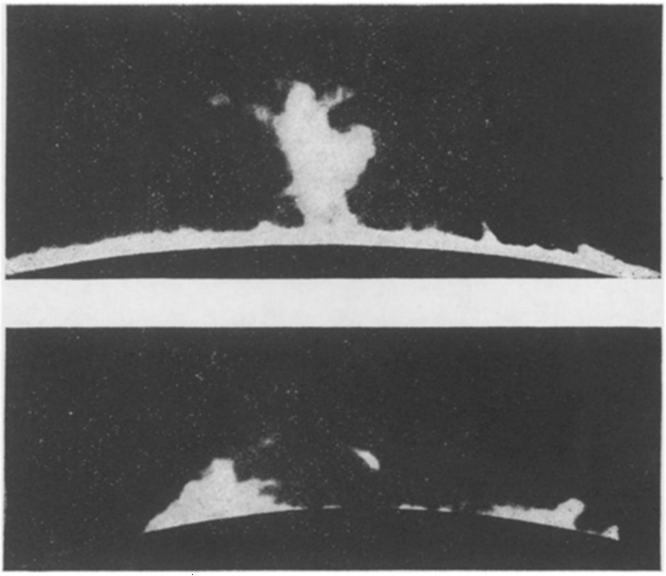

FIGURE 8.

Eruptive prominences of the sun. Photographed at the Yerkes Observatory. From Chamberlin, University of Chicago Press.

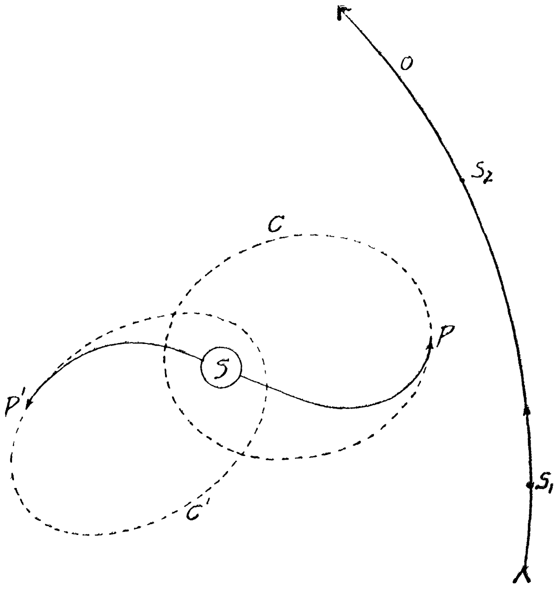

FIGURE 9.

Diagram by F. R. Moulton showing the supposed manner in which orbits and the spiral form of the nebula were formed. S is the ancestral sun of the solar system; the approaching sun passes along the path of the larger curve. When it is at the position S1 it draws a body at P' toward it in the direction of C'. As it passes on to S2 it acts similarly on the particles coming out towards P. The result is a loosely coiled spiral, with the particles composing it revolving around the central mass or sun. From Chamberlin.

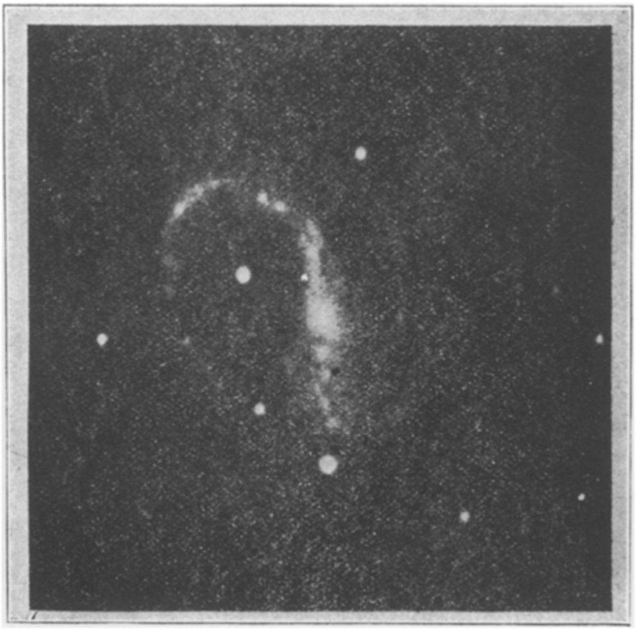

FIGURE 10.

A spiral nebula in the constellation Pegasi, in which the arms are remarkably distinct and very slightly coiled. This nebula is very much like the supposed solar system nebula would have been in its early stages, before the arms coiled closely. Compare this nebula with the one shown in Figure 5. From Chamberlin, University of Chicago Press.

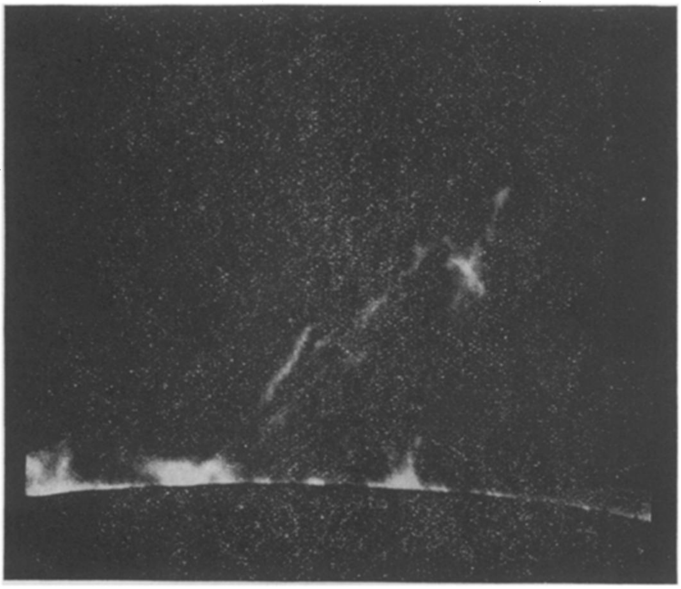

FIGURE 11.

An eruptive prominence of the sun in which there is a series of smaller knots projected with the main knot. Under the gravitative pull of a passing sun, such as postulated in the Planetesimal Hypothesis, there would be many such knots as these, but of even greater dimensions. Photographed at the Yerkes Observatory. From Chamberlin, University of Chicago Press.

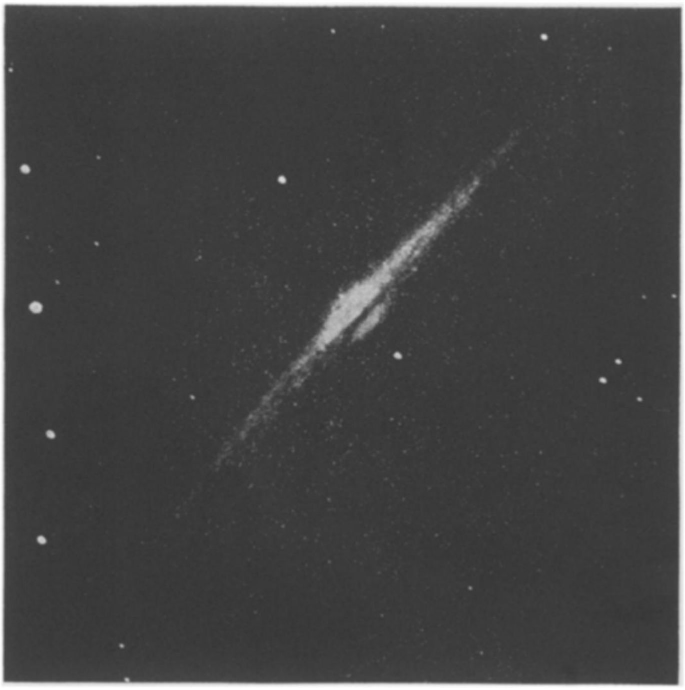

FIGURE 12.

An edge view of the spiral nebula HV 24, Comae Berenices, showing that it has a highly discoidal form. The dark band that shows across the central ball is probably caused by light-absorbing matter. The fact that spiral nebula are discoidal in form supports the hypothesis that the solar system, also discoidal, is descended from one of them. Photographed at the Lick Observatory. From Chamberlin, University of Chicago Press.

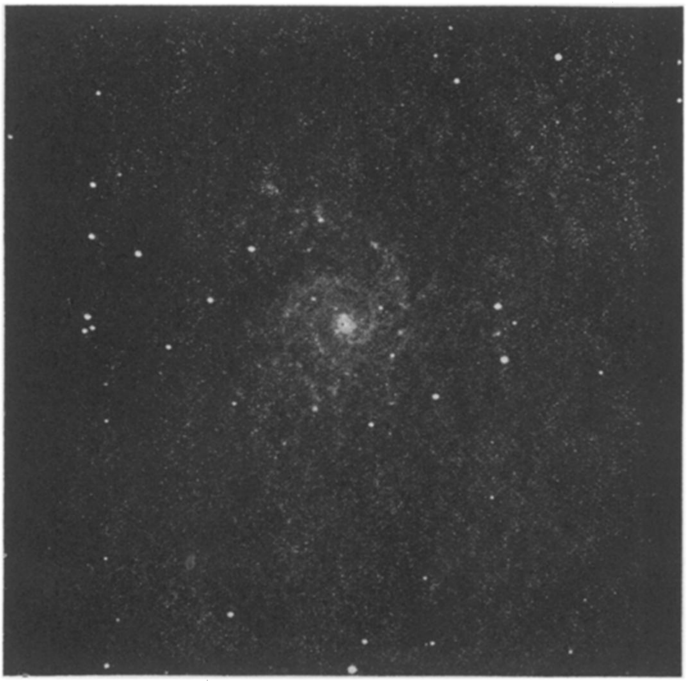

FIGURE 13.

The spiral nebula M 74, in the constellation Piscium. This nebula contains a large central body and two well-defined and closely coiled arms. The arms bear a large series of knots that seem to be highly suited to serve as collecting centers for the nearby, scattered nebulous matter. Photographed at the Lick Observatory. From Chamberlin, University of Chicago Press.

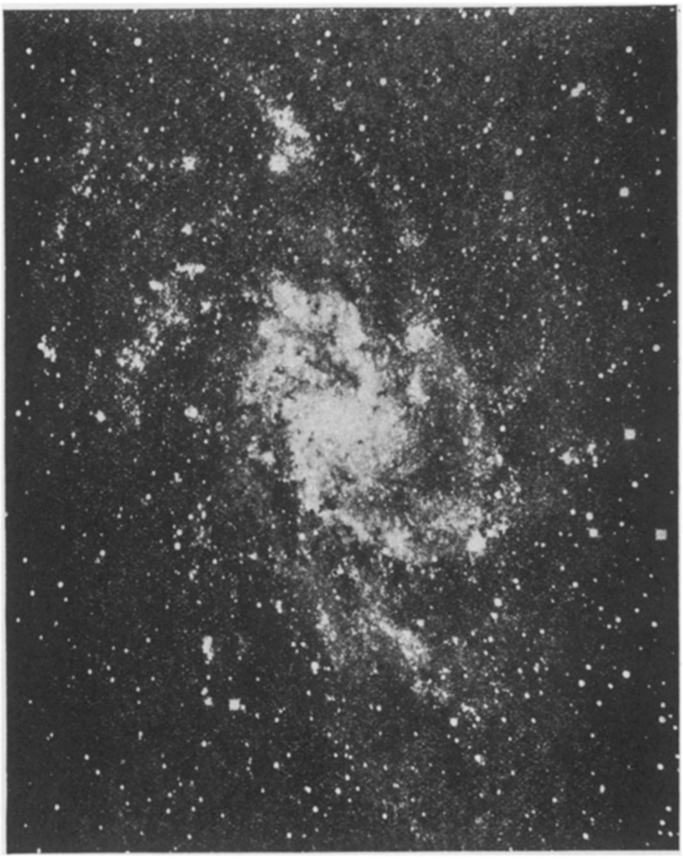

FIGURE 14.

The gigantic nebula M 33, in Triangulum. Even this immense nebula is not too large to have originated in the manner which Dr. Chamberlin assigns for the formation of the spiral nebulae. Photographed at the Yerkes Observatory. From Chamberlin, University of Chicago Press.

4.—Effects of the Planetary Hypothesis on Scientific Ideas.

Such a radical change of thought as that involved in the giving up of the Laplacian hypothesis and the acceptance, either provisionally or otherwise, of the newer ideas of Chamberlin and his co-workers could hardlly fail to affect scientific thought. We used to be taught that the earth was originally intensely hot; that its atmosphere was at the same time very heavy. We were told that the oceans were once composed of hot water, and that life could not exist until they had had time to cool. The atmosphere was said to be steadily decreasing in amount, and the atmosphere moon was held up to us as a horrible example of what the earth would some day come to.

Under the new hypothesis, conditions were very different, and these conditions coincide with the evidences of geology and bilogy. The earth was at one time, during the stage when it was just developing as a planet, too small to hold an atmosphere, just as is the case with the moon at the present time. Gradually the planet increased in size until it became large enough to hold an atmosphere—that is, about as large as the planet Mars. From that time on the earth has been growing, and its atmosphere increasing. When the oceans first formed they were probably no warmer than those of today, and the first life began in conditions essentially the same as those which now exist. Hundreds of millions of years ago there were great glaciers that reached far down into the torrid belt —to within 18 degrees of the equator, and hundreds of millions of years ago there were deserts, just as there are today. The interior of the earth is not inherited from a molten mass, nor is the center of the earth molten at the present time. Volcanoes, instead of springing from a great internal reservoir of molten material are comparatively superficial in their origin. These facts we know from geology and physics. They exist, yet they fit no known hypothesis but the Planetesimal. In closing, however, it will be well to bear in mind that the planetesimal hypothesis is not proved. The difference between a hypothesis and a theory is essentially the difference between perhaps and probably. A hypothesis that is well enough substantiated may become a theory. To many it seems that the planetesimal hypothesis is receiving this support, but the authors do not yet assign to it the element of certainty that is implied in the use of the word "theory."

There are some statements, however, that may be made with certainty. One of these is that neither the Laplacian hypothesis nor any modification of it, nor any of the hypothesis of the meteoritic group offer anything whatever of a satisfactory interpretation of the origin of the solar system. They have been definitely proved to possess no foundation, and to attempt to use them further, whether in geology or in any other science is futile. On the other hand, the planetesimal hypothesis stands out as the one existing explanation of the earth's origin which has not shown flaws. It is in accord with all known facts ,and as said before, explains some that were unknown at the time it was originally proposed. It affords a reasonable and satisfactory basis for scientific and popular thought, and as such a basis it is of almost inestimable value.

Nomenclatorial Notes on Certain American Plants.—I.

HOMER D. HOUSE.

BOTRYCHIUM ONEIDENSE (Gilbert) House, comb. nov.

This was originally described from Oneida county, New York, as a variety of *Botrychium ternatum* (Fern Bul. (9) 27. 1901), and later (Walters, Ferns p. 334. 1903), transferred to *Botrychium obliquum* as a variety. Additional collections from Albany and Greene counties indicate that it is more properly to be regarded as a distant species.

AGROSTIS PECKII House, nom. nov.

A. caespitosa Torrey, Ann. Lyc. N. Y. (1) : 152. 1824. Not Salisb.

Trichodium montanum Torr. Fl. N. & Mid. U. S. (1) : 84. 1824. Not *Agrostis montana* R. Br.

A. torreyi Kunth, Enum. (1) : 226. 1833.—Tuckerman in Hovey's Mag. Hort. (9) : 143. 1943. Not *A. torreyana* Schultes, 1824.

A. laxiflora var. *montana* Tuckerm. Am. Jour. Sci. (45) : 43. 1843.

A. laxiflora var. *caespitosa* Torrey, Fl. N. Y. (2) : 442. 1843.

A. oreophila (Trinius, misapplied by) Nash, in Britton & Brown,